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Comparison of probe and spectroscopic electron temperature measurements in a h.f. hydrogen plasma

D R Gupta

Department of Physics, University of Jodhpur, Jodhpur

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McGregor (1966) has experimentally found that there is an equivalence of the electron temperatures (found by the probe method) and the excitation temperatures (found by the spectroscopic method) for an argon d.c plasma. Ferdinand (1970) has compared the results for the electron temperatures measured by the spectroscopic and the probe methods for the plasma of an H_2–O_2 flame. The author has presently compared electron temperatures in an h.f. plasma of hydrogen gas by the spectroscopic and the double probe methods and the results of T_e have been concurrently checked by calculating T_e using Stoenbeck's formula

For the probe measurements the pyrex glass discharge tube having a length of 51 5 cm and diameter 4 5 cm was used The probe was made of a tungsten wire 0 2 mm in diameter and provided with a capillary cover It was located at the middle of the tube and projected radially inside the tube, having a collecting length of 1 cm terminating at the axis of the tube. The anti-probe was in the form of a grid having a surface area about 150 times as compared to the probe area. The distance between the probe and anti-probe was 3 cm Two external sleeve electrodes of 1 cm wide thin copper foils were used and connected to the Hartley oscillator for exciting the discharge Hydrogen gas was introduced

into the tube by diffusion through a palladium tube. The discharge was studied at five pressures viz. 0.03, 0.07, 0.13, 0 19 and 0.25 torr. and the pressures were measured by the Pirani gauge. The excitation frequency was 18 MHz, and voltage 300 volts. The electron temperatures were calculated from the slope of the curve between $\log\left(\frac{\Sigma I}{i_p}-1\right)$ and V where ΣI is total ionic current to the probe assembly and i, the electronic current to the probe and V, the p d between the probe assembly The results for electron temperatures are reproduced below in the table.

The electron temperatures have been also calculated by using the theoretical formula of Engel & Steenback (1934)

$$\frac{e^x}{\sqrt{x}} = 1\cdot16\times10^7C^2p^2R^2$$

where $x = eV_i/kT_e$, in which e is electronic charge, V_i in onisation potential, k Boltzmann's constant T_e electron temperature and C is a constant whose value for hydrogen is given to be $1\cdot35\times10^{-2}$, R the radius of discharge tube P the pressure in mm Hg

The set up used for spectroscopic determination of the electron temperatures consisted of the discharge tube and a vacuum system the same as used for the probe study, the discharge is studied under the conditions identically the same as those for the probe experiments The central part of the glow column is focussed on the slit of a Hilger C D spectrograph having a dispersion of about 18 A.U./mm at 4600 A U. which is about the mean wave length region of the singlet and tuiplets to be measured The photographs of the spectra are taken on Kodak plates for identification of the lines. The intensity of lines is measured by a Moll self recording microphotometer. The electron temperatures were computed from the curves given by Brasefield (1930) The results are reproduced below :

Table 1

S.No.	Pressure of hydrogen gas in mm. Hg.	T_e, measured by probe method °K	T_e calculated	T_e by spectroscopic method °K
1.	0.03	60,000	56,000	58,000
2.	0.07	57,500	50,000	54,000
3.	0.13	45,000	35,000	36,000
4.	0.19	42,000	30,500	26,000
5.	0.25	41,000	28,000	25,000

It is seen that at higher pressures the spectroscopic values of the electron temperatures do not agree with the probe values This may be due to non-reliability of the values because of increased number of molecular collisions at those pressures which may affect process of excitation and the intensity of lines from which determination of T_e is made by spectroscopic method However we could have a check for the probe value of T_e by an alternative experimental set up

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